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A Visit To A High Voltage DC Experimental Data Center

On August, 16th, representatives from the PSMA Energy Efficiency Committee visited a unique and experimental Data Center facility to see and discuss its new dc power architecture. This dc power architecture was designed and managed by Lawrence Berkeley Laboratories (LBL), EPRI Solutions and Ecos Consulting with funding for the project through the California Energy Commission (CEC).

The Data Center is located at SUN Microsystems's Newark, California facility. This on-going project has many stakeholders including Intel Corporation, Cisco Systems, Emerson Network Power and others. A complete list of the stakeholders along with more project details, are available on the web site:

http://hightech.lbl.gov/dc-powering/.

This experimental data center employs a high-voltage dc power architecture. The facility demonstrates that, by using high voltage dc bus (380 Vdc), the entire power system can be simplified, efficiently deployed and result in lower utility bills. After the front-end ac to dc conversion, the 380 Vdc is distributed at the frame level to racks of servers that have been modified to accept the high voltage dc. The high voltage dc is converted to a standard intermediate bus architecture within the servers. This data center is defined as "DC Power" to distinguish it from the traditional "AC Power" because of the nature of the power distribution.

In a traditional data center, significant losses occur due to ac to dc conversion from the utility supply and then the ac to dc double conversion in an online UPS deployed at the front-end for the system backup required to meet availability objectives. In the dc approach, a dc UPS (battery plant) eliminates the need for double conversion.

In a traditional "AC Power" data center the each stage of conversion incurs some losses – the efficiency of the traditional UPS is typically 88-92%; the efficiency of the power distribution (PDU) is typically 98-99%; the efficiency of the power supply (PSU) is 68-72% and the efficiency of the dc-dc converters is typically 78-85%. As a result, the cumulative power system efficiency is between 45 to 56%. In addition, the facility requires additional cooling due to heat generated by the losses at every power conversion stage and a larger sized motor generator for long term reserve power.

In this "DC Power" data center, the entire system is dc operated eliminating several conversions and resultant losses. Since this is an experimental facility to show the benefits of dc distribution, the facility also provided a comparison between the traditional ac distribution and the experimental dc distribution system.

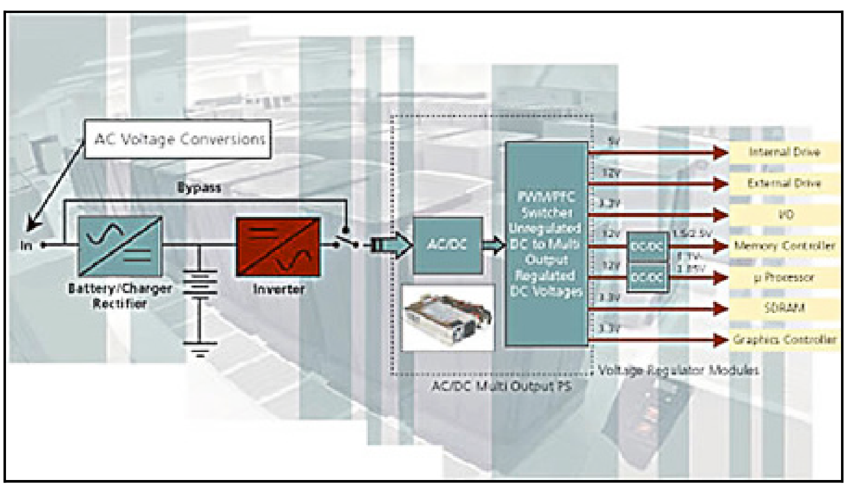
The "DC Power" power architecture replaces the front-end ac UPS by a dc UPS (ac-dc front end rectifier with a battery backup unit (BBU)) that delivers 380Vdc output. This 380 Vdc is then converted to an intermediate bus 12 Vdc distribution followed by board level VRMs to provide the power for the load.

The dc distribution system eliminates the need for double conversion associated with the traditional ac UPS and Power Distribution Unit (PDU) and the ac-dc power supply resulting in an overall efficiency improvement between 10 to 20% for the facility. With today's kwh utility costs, a 15% efficiency improvement results in a $2.7 million yearly savings in utility bills for a 10Mw system. With significant growth in the size and number of data centers and servers expected in coming years, this saving is expected to increase to $13 million for future 50 mw data centers.

This "DC Power" design took a different approach at the power systems architecture from the efficiency and cost-related issues. The power system components were not custom designed and were any special customization required. This data center looked like a typical telecom central office power plant except the distributed voltage was 380 Vdc instead of 48 Vdc.

High voltage dc bus architectures have been previously used only in some special high-end computer applications. But now, with higher energy prices and the emphasis on high efficiency, the power supply industry needs to take a fresh look at this dc power architecture and be an active participant in its development for the benefit of companies, society and the bottom line.

There are still a number of technical and cost issues that need further study and discussion. These include practical issues such as safety, reliability, and grounding and equipment issues relating to connectors, arcing, and short-term and long-term costs. The "DC Power" project team welcomes any input on these issues. A comprehensive report on all these aspects of DC Powering will be completed during the fall of 2006.



In typical data centers, the loss in electrical power through conversions of AC to DC to AC to DC occurs for all power flowing to the IT equipment. Efficiency gains have a magnifying effect by reducing need for HVAC (e.g. 10% saving at the UPS level could mean 20% saving for the data center).

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The views expressed in this article are solely of Mohan Mankikar. They do not represent views of PSMA. Mohan Mankikar has been a part of the power supply industry for over twenty five years. An active member of the PSMA since its founding, he had been a board member of the PSMA and currently acts as an advisor.

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